

Substitution

Notes and guidance

In this small step, children find values of expressions by substituting numbers in place of the letters.

Children should understand that the same expression can have different values depending on what number is substituted into it. Before working with letters, children explore concrete and pictorial representations. By assigning values to, for example, a square and a triangle, they can work out square + triangle. Similarly, building on representations from the previous step, if they assign a value to a cube, they can work out the value of an expression.

Children then move on to substituting numbers into abstract algebraic expressions such as $3a + 1$. This can be linked to the earlier learning of function machines, and thought of as “multiply by 3 and then add 1”, or bar models, replacing each occurrence of the letter with its value.

Things to look out for

- Children may think that a is always equal to 1, b always equal to 2 and so on.
- If $a = 3$, children may see $2a$ as 23 rather than $2 \times 3 = 6$
- Children may misinterpret expressions such as $2a + 3$ as $5a$.

Key questions

- If 1 cube is worth _____, what are 3 cubes worth?
- What does $4x$ mean? If you know the value of x , how can you work out the value of $4x$?
- What does “substitute” mean?
- How can you represent the expression as a bar model? Which parts of the bar model can you replace with a number? What is the total value of the bar model?
- Which part of the expression can you work out first? What is the total value of the expression?

Possible sentence stems

- If _____ is worth _____, then _____ is worth _____
- To work out the value of _____, I need to replace the letter _____ with the number _____ and then calculate _____

National Curriculum links

- Use simple formulae
- Express missing number problems algebraically

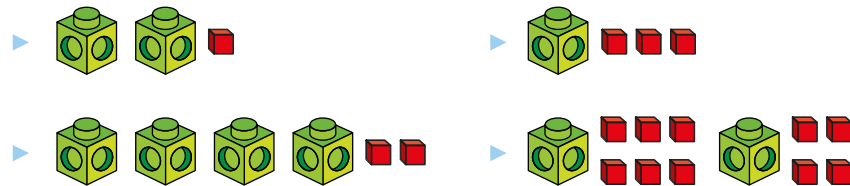
Substitution

Key learning

- Ann gives values to these cubes.

$$\text{Green cube} = 5 \quad \text{Red cube} = 1$$

Work out the values of the sets of cubes.



- Tom draws three shapes and gives each one a value.

$$\text{Blue square} = 3 \quad \text{Red triangle} = 4 \quad \text{Green circle} = 5$$

Work out the values of the expressions.



- Here are three expressions.

$$5a \quad a + 5 \quad 10 - a$$

- ▶ Which expression has the greatest value when $a = 1$?
- ▶ Which expression has the greatest value when $a = 5$?
- ▶ Which expression has the greatest value when $a = 10$?
- Esther generates a sequence by substituting $n = 1, n = 2, n = 3, n = 4$ and $n = 5$ into the expression $4n + 1$

$$\text{When } n = 1, \\ 4n + 1 = 4 \times 1 + 1 = 4 + 1 = 5$$

Work out the other numbers in Esther's sequence.

What patterns can you see?

- If $a = 5$ and $b = 12$, work out the values of the expressions.

$$a + b \quad b - a \quad 2b - a \quad a + 3b \quad b \div 2 \quad 20 \div a$$

Substitution

Reasoning and problem solving

$$x = 2c + 6$$



Mo

$x = 12$, because c must be equal to 3 as it is the 3rd letter in the alphabet.

Is Mo correct?

Explain why.

No

Kim has put the 2 next to the 5 to make 25, instead of multiplying 2 by 5



Kim

When $c = 5$,
 $x = 31$

Explain why Kim is wrong.

What is the correct value of x when $c = 5$?

 $x = 16$

Work out the missing values in the table.

x	$3x$	$3x + 5$
1		
3		
	12	
	36	
		20
		26

row 1: 3, 8

row 2: 9, 14

row 3: 4, 17

row 4: 12, 41

row 5: 5, 15

row 6: 7, 21

Find the value of c when $a = 10$

$$p = 2a + 5$$

$$c = 10 - p$$

 $c = -15$